REL Technical Brief

REL 2012–No. 025

REL MID-ATLANTIC
Regional Educational Laboratory
At Pennsylvania State University

Analyzing performance by Pennsylvania grade 8 Hispanic students on the 2007/08 state assessment

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April 2012

ies NATIONAL CENTER FOR EDUCATION EVALUATION AND REGIONAL ASSISTANCE
Institute of Education Sciences

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April 2012

This REL Mid-Atlantic Technical Brief responds to a concern by educators and decisionmakers in Pennsylvania about a 29 percentage point gap between White and Hispanic grade 8 students in Pennsylvania in reading performance and a 28 percentage point gap between these groups in math performance on the 2009 National Assessment of Educational Progress, particularly as the Hispanic student population in Pennsylvania is growing.

This REL Technical Brief was prepared for IES under Contract ED-06-CO-0029 by Regional Educational Laboratory Mid-Atlantic administered by Pennsylvania State University. The content of the publication does not necessarily reflect the views or policies of IES or the U.S. Department of Education, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

Pong, S., Strickland, M., and Wise, J. (2012). *Analyzing performance by Pennsylvania grade 8 Hispanic students on the 2007/08 state assessment.* (REL Technical Brief, REL 2012–No. 025). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Mid-Atlantic. Retrieved from http://ies.ed.gov/ncee/edlabs.

This REL Technical Brief is available on the Regional Educational Laboratory website at http://ies.ed.gov/ncee/edlabs

Summary

Between 2000 and 2009, the Hispanic population more than doubled in 25 of 67 Pennsylvania counties. Over the same period, the Hispanic student population in Pennsylvania schools also rose, from 4 percent to 8 percent (Pennsylvania State Data Center 2011). The focus on Hispanic students' level of academic achievement rose along with this rapid population growth.

Recent research reveals that, although the achievement gap between ethnic subgroups at the national level has been shrinking over the past five years, the gap remains wide (Aud et al. 2010). This is also the case and a matter of concern in Pennsylvania.

Research has identified several student-level factors associated with academic achievement among ethnic minority students, including gender and socioeconomic status (Freeman 2004; McGraw, Lubienski, and Strutchens 2006; Pong 2010); English language learner status (Eamon 2005; Reardon and Galindo 2007; Terwilliger and Magnuson 2005); special education status (Sanchez et al. 2009); and mobility (Suárez-Orozco, Gaytán, and Kim 2010). School-level factors also influence student achievement. One contributing factor is the proportion of special needs students in a school, whether because they come from a low-income household (Sirin 2005), have a disability (Kalambouka et al. 2007), or are English language learner students (Schmid 2001). School-level factors also include school dropout rates (Sanchez et al. 2009), school size (Crosnoe 2005), the proportion of ethnic minority students (Coleman 1966), student–teacher ratio (Nye, Hedges, and Konstantopoulos 2004), and school locale (Pong 1998).

Two research questions guided this study:

- How does the performance of Pennsylvania grade 8 Hispanic students on the 2007/08 Pennsylvania System of School Assessment English language arts and math tests compare with that of grade 8 non-Hispanic White, Black, and other non-Hispanic students?
- Among Pennsylvania grade 8 Hispanic students, which student- and school-level characteristics are associated with performance on the 2007/08 Pennsylvania System of School Assessment English language arts and math tests?

The data used for this study were the Pennsylvania System of School Assessment (PSSA) scores collected by the Data Recognition Corporation for the Pennsylvania Department of Education. In addition to the PSSA, the Pennsylvania Department of Education's Bureau of Assessment and Accountability provided demographic data for all grade 8 students in 2007/08, and publicly available school-level data were also accessed from the department's website. Additional demographic school data were obtained from the publicly accessible Common Core of Data of the National Center for Education Statistics (U.S. Department of Education 2008).

Key findings show:

- The difference in performance of grade 8 Hispanic students and non-Hispanic students was 174 scaled score points on the PSSA reading test and 123 scaled score points on the math test.
- Scores on both the PSSA reading and math tests were significantly lower for Hispanic students than for White students and for students of other ethnicities. Hispanic

students' and Black students' scores were not significantly different on the reading test, but scores on the math test were significantly higher for Hispanic students than for Black students.

- There was a statistically significant relationship between Hispanic students' PSSA test scores and gender, special education status, eligibility for free or reduced-price lunch status,[1] and English language learner status. There was not a statistically significant relationship between PSSA scores and migrant status.
- There was a statistically significant relationship between Hispanic students' PSSA test scores and school size, the proportion of Hispanic students eligible for free or reduced-price lunch, and whether the school reported having students who dropped out.[2] There was not a statistically significant relationship between PSSA scores and the percentage of grade 8 English language learner students, percentage of grade 8 students receiving special education services, percentage of Hispanic students, student–teacher ratio, and school locale (urban, suburban, town, or rural).

April 2012

Technical brief

Why this brief?

Between 2000 and 2009, the Hispanic population more than doubled in 25 of Pennsylvania's 67 counties, and the Hispanic student population in Pennsylvania schools rose from 4 percent to 8 percent (Pennsylvania State Data Center 2011). With this rapid population growth, the focus on Hispanic students' level of academic achievement has also increased. Although the achievement gap between ethnic subgroups has been shrinking at the national level over the past five years, the gap remains wide nationally (Aud et al. 2010). This is also the case and a matter of concern in Pennsylvania.

To learn more about this gap in Pennsylvania, this brief compares Pennsylvania grade 8 Hispanic students and their non-Hispanic counterparts on state tests of English language arts and math. It examines the association between Hispanic students' test performance and several student- and school-level characteristics.

National trends

The Hispanic population is the largest racial/ethnic minority group in the United States, accounting for more than half the country's population growth over 2000–10 (Humes, Jones, and Ramirez 2011). Despite making up about 20 percent of public school K–12 students nationwide (Suárez-Orozco, Gaytán, and Kim 2010), Hispanic students are also the most educationally disadvantaged racial/ethnic group—by a number of measures (Schneider, Martinez, and Owens 2006). An achievement gap persists between Hispanic students and their non-Hispanic peers throughout middle and high school. Further, Hispanic youth are less likely than either White or Black youth to feel a sense of belonging in school (Schneider et al. 2006).

Although the math proficiency of Hispanic students as a group is similar to that of Black students in elementary school, Mexican-origin students (the largest Hispanic subgroup) have lower math proficiency scores in elementary grades than any other racial/ethnic subgroup, including Black students (Reardon and Galindo 2007). Hispanic high school students take fewer advanced math courses than their White counterparts and fewer advanced science courses than either White or Black students (Schneider, Martinez, and Owen 2006).

About 33 percent of Hispanic children who enter kindergarten do so with two or more risk factors, such as low maternal education, single-parent household, welfare dependency, and parental low proficiency in English (Schneider, Martinez, and Owens 2006). The percentage of Black children facing two or more risk factors is 6 percentage points lower, at 27 percent. Hispanic students have also been reported to have higher dropout rates and lower school completion rates than any other racial/ethnic subgroup (Planty et al. 2008).

In light of these findings, it is important that policymakers understand individual and school factors in Hispanic students' academic performance (Miguel and Donato 2010).

Pennsylvania trends

Mirroring the rise in the Hispanic population across the United States, Pennsylvania saw a 64 percent increase in the Hispanic population over 2000–09 (Pennsylvania State Data Center 2011). The 2010 census data recorded Hispanics as the fastest growing racial/ethnic minority group in the state (Pennsylvania State Data Center 2011). Of 67 Pennsylvania counties, 25 (37 percent) saw their Hispanic population more than double over 2000–09 (Pennsylvania State Data Center 2011). At the same time, the non-Hispanic population across the state declined 1.4 percent.

In 2009/10, Hispanic students made up 8 percent of Pennsylvania's public school

population, twice the 4 percent in 1999/00 (Pennsylvania State Data Center 2000; U.S. Department of Education 2011). This demographic shift has become a key focus in the education and political discourse. On December 3, 2009, the Pennsylvania Governor's Advisory Commission on Latino Affairs and the Pennsylvania Department of Education held a Latino Students Educational Excellence Summit. Teachers, administrators, schools of higher education, businesses, and nonprofit organizations were represented, and the conversation focused on the increasing number of Hispanic students entering Pennsylvania schools and the achievement gap between Hispanic students and other racial/ethnic subgroups. The Pennsylvania Department of State Secretary of the Commonwealth talked about the need for better understanding of Hispanic student achievement and pointed to the Obama administration's focus on Hispanic student achievement. This emphasis was later reinforced nationally when President Obama signed the "White House Initiative on Educational Excellence For Hispanics" on October 19, 2010 (Executive Order 13,555 2010).

The achievement of Hispanic students is increasingly a concern for educators and decisionmakers in Pennsylvania, particularly as the Hispanic student population is growing. The 2009 National Assessment of Educational Progress (NAEP) data indicated a 29 percentage point gap between White and Hispanic grade 8 students in Pennsylvania in reading performance and a 28 percentage point gap between these groups in math performance (NAEP 2009a,b).[3] (See appendix A for a more comprehensive discussion of the literature.)

To learn more about this gap, this report compares the performance of grade 8 Hispanic students and their non-Hispanic counterparts on the Pennsylvania System of School Assessment (PSSA) tests of English language arts and math (see box 1 for definition of key terms). The PSSA is a standards-based, criterion-referenced assessment that measures a student's attainment of academic standards. Every Pennsylvania student in grades 3–8 and grade 11, unless excused as described below, is assessed in English language arts (reading) and math (Data Recognition Corporation 2009).[4] Scores reveal the performance of the population of Pennsylvania public school students and offer additional insight on performance when compared with the NAEP scores, which are based on students from a sample of available schools. PSSA scores have been found to be reliable and valid (Thacker 2004).

Students may be excused from participating in the PSSA for several reasons: by parental request, if they are assessed through alternate means, if they experienced an extended absence, if they should have but have not yet received an individualized education program, if they have been identified as an English language learner (ELL) student and are in their first year of enrollment in the United States, or if they have a medical emergency.

Research questions

Two research questions guide this study:

- How does the performance of Pennsylvania grade 8 Hispanic students on the 2007/08 Pennsylvania System of School Assessment English language arts and math tests compare with that of grade 8 non-Hispanic White, Black, and other non-Hispanic students?
- Among Pennsylvania grade 8 Hispanic students, which student- and school-level characteristics are associated with performance on the 2007/08 Pennsylvania System of School Assessment English language arts and math tests?

This study focuses on grade 8 for two reasons. First, national and state attention on Hispanic student academic performance focuses on middle school, a pivotal time for school attachment and intervention for lowering the high school dropout rate (LeCroy and Krysik

BOX 1

Key terms

Dropout. A student who, for any reason except death, leaves school before graduation without transferring to another school or institution. School districts provide dropout data to the Pennsylvania Department of Education. This study treats "school without dropout" as a discrete dichotomous variable and thus does not account for differences in dropout rates.

English language learner student. According to the Pennsylvania Department of Education, a student whose dominant language is not English. The designation is based on information received from a home language survey and the results of the Assessing Comprehension and Communication in English State-to-State for English Language Learners Placement Test of the World-Class Instructional Design and Assessment.

Ethnicity. In the PSSA records, ethnicity is disaggregated into six categories: American Indian or Alaskan Native, Asian or Pacific Islander, Black/African American non-Hispanic, Latino/Hispanic, White non-Hispanic, and multi-racial/ethnic. This report uses the term "ethnicity" rather than "race/ethnicity" because that is the term used by education leaders and policymakers in Pennsylvania, the primary audience for this report.

Free or reduced-price lunch eligibility. A proxy for low-income status. Children from a household with an income at or below 130 percent of the poverty level are eligible for free meals. Children from a household receiving Temporary Assistance for Needy Families or food stamp benefits automatically qualify for free meals. Children from a household whose income is 130–185 percent of the poverty level are eligible for reduced-price meals (Pennsylvania Department of Education n.d. b).

Hispanic student. As defined on Pennsylvania's 2007/08 standardized tests, all students whose parents came from Cuba, the Dominican Republic, Mexico, Puerto Rico, Central or South America, or any other country once colonized by Spain. This variable was self-reported.

Migrant. "Any child domiciled temporarily in any school district for the purpose of seasonal or temporary employment, but not acquiring residence therein, and any child accompanying his parent or guardian who is so domiciled" (Pennsylvania Department of Education 2008, p. 6). School personnel make this designation.

Multilevel modeling. A statistical technique that accounts for the nested structure of data, as when students are grouped into larger units, such as the classroom or school.

Multiple imputation. A statistical technique that replaces missing values through simulation. Each complete dataset with simulated values is analyzed using standard methods, and the results are combined to produce estimates that incorporate missing-data uncertainty.

Pennsylvania System of School Assessment (PSSA). The annual standards-based, criterion-referenced assessment used to measure a student's attainment of academic standards. Each student in grades 3–8 and 11 is assessed in reading and math, each student in grades 5, 8, and 11 is assessed in writing, and each student in grades 4, 8, and 11 is assessed in science (Pennsylvania Department of Education 2008).

School-level characteristics. School size, percentage of grade 8 English language learner students, percentage of grade 8 students receiving special education services, percentage of students receiving free or reduced-price lunch, student–teacher ratio, dropout status, and school locale (urban, suburban, town, or rural). These variables, defined in appendix E, are from the Common Core of Data (U.S. Department of Education 2008).

Special education. A student with an individualized education program (not including gifted programs).

Standard deviation. A measure of variability quantifying the average distance of a set of scores from the mean of the scores. The PSSA reports scores in standard deviation units.

Standard error. A statistical term representing how accurately a sample represents a population. The mean for a sample drawn from a population will be different from the mean for the whole population. This difference is the standard error.

Student-level characteristics. Gender, special education status, eligibility for free or reduced-price lunch, English language learner status, and migrant status. These variables, defined in appendix E, were obtained from the PSSA dataset.

2008). Second, Pennsylvania policymakers have noted the importance of intervening with Hispanic students in middle school for increasing academic achievement and graduation rates.

The PSSA dataset was provided to the researchers by the Pennsylvania Department of Education with no student identifiers to protect student confidentiality. The data from the PSSA and the Common Core of Data (U.S. Department of Education 2008) for 2007/08 were the most complete data at the time of this study and were chosen for that reason. As newer datasets based on the same assessments become available to the Pennsylvania Department of Education, this study can be updated using the same methodology (see box 2 and appendixes B–D for a description of the data sources and study methods).

Comparison of performance of Hispanic and non-Hispanic students on the 2007/08 grade 8 Pennsylvania System of School Assessment English language arts and math tests

The performance of grade 8 Hispanic students in Pennsylvania, compared with their non-Hispanic counterparts, was examined using the English language arts (reading) and math scaled scores from the 2007/08 PSSA. Non-Hispanic students were first analyzed as a single group and then separately as non-Hispanic White students ("White"), non-Hispanic Black students ("Black"), and other non-Hispanic students ("other").[5]

Comparisons of characteristics of Hispanic and non-Hispanic student populations

To establish a context for the discussion on differences in test performance, several

BOX 2

Data and methods

The data for this study come from three sources:

- The Pennsylvania System of School Assessment (PSSA) data, provided by the Pennsylvania Department of Education, show students' test performance and demographic characteristics for 2007/08. The PSSA data cover the population of grade 8 students from all of Pennsylvania's regular public schools, including charter schools.
- Pennsylvania public school data were extracted from the 2007/08 Common Core of Data (U.S. Department of Education 2008). The data contain unique state school identification numbers that the study could link to the PSSA.
- School dropout data for 2007/08 came from the Pennsylvania Department of Education website (Pennsylvania Department of Education n.d. a). The study linked the dropout data to the PSSA through school names.

Descriptive analyses were conducted to compare the performance of grade 8 Hispanic students on the English language arts and math tests with that of grade 8 non-Hispanic students as a group and separately as White students, Black students, and students of other ethnicities.

Among the PSSA grade 8 students, 2,952 (2 percent) were missing English language arts test scores, and 1.8 percent (2,609) were missing math test scores. Also, 204 students (less than 1 percent) were missing information on gender. After students with missing data were removed, the descriptive analyses were based on 140,967 grade 8 students (98 percent). The removal of such a small percentage of students was not expected to bias the results (appendix B).

The Common Core of Data dataset, however, was missing a substantial number of values (33 percent). Multiple imputation was used to address missing data (appendix C), and sensitivity analyses were conducted to test the effect of the missing data procedures on study outcomes (appendix D).

Multilevel modeling was applied to examine the associations between student- and school-level characteristics and Hispanic students' performance on the PSSA. (See appendix E for more details on the methodology, including the multilevel equations.)

comparisons were made between the Hispanic and non-Hispanic student populations (table 1). In 2007/08, 9,040 grade 8 students in Pennsylvania were Hispanic (6.4 percent of the total grade 8 population of 140,967). Of the remaining 131,927 non-Hispanic grade 8 students, 80 percent (105,644) were White, 17 percent (21,869) were Black, and 3 percent (4,414) were American Indian/Alaskan Native, Asian/Pacific Islander, or multiracial (grouped as "other").

Descriptive statistics in table 1 show similar gender composition within and between groups but noticeable differences in several student variables between Hispanic and non-Hispanic grade 8 students (these differences are significant at the $p = 0.001$ level using a chi-square test):

- Hispanic students were more likely to be eligible for free or reduced-price lunch (71.8 percent) than were non-Hispanic students (30.3 percent).
- Hispanic students were more likely to receive special education services (16.9 percent) than were non-Hispanic students (14.6 percent).
- In 2007/08, 17.6 percent of Hispanic grade 8 students were current ELL students, compared with 0.7 percent of non-Hispanic grade 8 students. Just 1.3 percent of non-Hispanic students were current or former ELL students, compared with 30.0 percent of Hispanic students.
- Migrant students constituted a small share of the total grade 8 population in Pennsylvania, and most migrant students were Hispanic (2.8 percent of Hispanic students).

Hispanic and non-Hispanic grade 8 students differed in the characteristics of the schools they attended, and in many cases the differences were statistically significant (table 2). Hispanic students attended schools with significantly more peers receiving special education services, significantly more English language learner students, and significantly more students of their own ethnicity than did non-Hispanic students. Hispanic students' schools had a significantly higher percentage of students eligible for free or reduced-price lunch, and were significantly more likely to be located in cities than were schools attended by non-Hispanic students. However, Hispanic students attended schools similar to those attended by non-Hispanic students in student–teacher ratio, school size, and whether the school had dropouts.

TABLE 1

Characteristics of grade 8 Hispanic, White, Black, and other ethnicity students in Pennsylvania, 2007/08

Student variable	Hispanic (n = 9,040)	White (n = 105,644)	Black (n = 21,869)	Other (n = 4,414)	All non-Hispanic (n = 131,927)
Male	50.2	51.4*	50.2	50.8	51.2
Eligible for free or reduced-price lunch	71.8	22.0***	69.2	34.8***	30.3***
Special education	16.9	14.2***	18.0	6.6***	14.6***
Current English language learner	17.6	0.3***	1.0***	10.1***	0.7***
Former English language learner	12.4	0.3***	0.4***	10.9	0.6***
Never an English language learner	70.0	99.5***	98.6***	79.0***	98.6***
Migrant	2.8	0.01***	0.03***	0.4***	0.03***

* Significantly different from Hispanic students at $p = 0.05$; *** significantly different from Hispanic students at $p = 0.001$.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education.

TABLE 2
School characteristics for grade 8 Hispanic and non-Hispanic students in Pennsylvania, 2007/08

School variable	Hispanic	Non-Hispanic
Percentage of grade 8 students receiving special education services	17.3	15.4*
Percentage of grade 8 English language learner students	21.7	2.2***
Percentage of grade 8 Hispanic students	59.7	4.1***
Percentage of students eligible for free or reduced-price	80.7	31.0***
Student-teacher ratio	14.4	14.3
School size	821.4	787.3
School with no dropouts	0.90	0.85
Suburban school	0.09	0.49***
School in town	0.01	0.16***
Rural school	0.02	0.20***
Urban school	0.88	0.15***

* Significantly different from Hispanic students at $p = 0.05$; *** significantly different from Hispanic students at $p = 0.001$.

Note: There were a total of 886 schools. The *p*-values were based on *t*-tests and show differences in school characteristics between Hispanic and non-Hispanic students. The school statistics for Hispanic and non-Hispanic students were weighted by the proportion of Hispanic and non-Hispanic students who attended the school to represent the characteristics of schools that average Hispanic students attended and those that average non-Hispanic students attended.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education.

Test performance comparisons

In 2007/08, Hispanic students in Pennsylvania had lower reading and math scores than did non-Hispanic students. The average scaled reading score for Hispanic students was 1,281, 174 points lower than the average for non-Hispanic students (1,455; figure 1).

Similarly, the average scaled math score for Hispanic students was 1,281, 123 points lower than the average for non-Hispanic students (1,404; figure 2). The differences in both the reading and math test score were statistically significant.

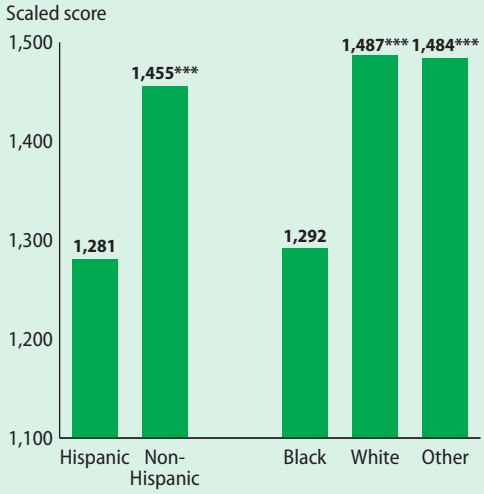
When non-Hispanic students were disaggregated into Black students, White students, and other students (students of other race/ethnicity), Hispanic students still scored lower on both the reading and math tests than White students and other students (tables 3 and 4). For reading, White students and other students scored significantly higher than Hispanic students, while Black students did not score differently. For math, White students and other students scored significantly higher than Hispanic students. The Hispanic–White gap, to the disadvantage of Hispanic students, was about 206 scaled score points in reading and about 150 scaled score points in math. On the reading test, Hispanic students performed similar to Black students, with an 11 scaled score point difference in favor of Black students. On the math test, Hispanic students scored 27 scaled score points higher than Black students.

Associations between grade 8 Hispanic student performance on the Pennsylvania System of School Assessment and student- and school-level characteristics

The second research question examines whether student and school characteristics are associated with Hispanic student performance on the PSSA. Of the 886 schools studied, 282 had no Hispanic students in grade 8, and 235 had only one or two. Five percent of these 886 schools had 50 or more Hispanic students in grade 8, while less than 1 percent had

FIGURE 1

Average scaled reading scores on the Pennsylvania System of School Assessment for grade 8 Hispanic and non-Hispanic students, 2007/08



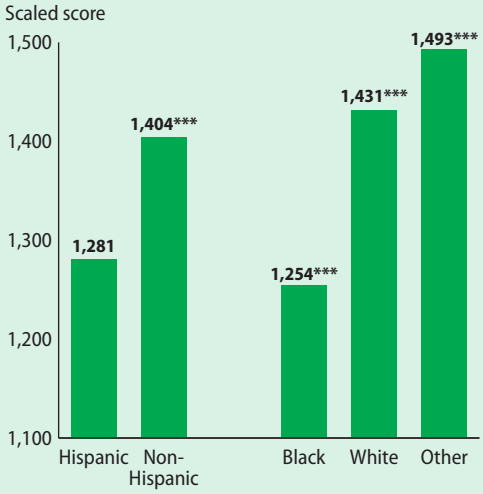
*** Significantly different from Hispanic students at $p = .001$.

Note: Scaled scores range from 700–2,646 (mean = 1,444; standard deviation = 247).

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education.

FIGURE 2

Average scaled math scores on the Pennsylvania System of School Assessment grade 8 Hispanic and non-Hispanic students, 2007/08



*** Significantly different from Hispanic students at $p = .001$.

Note: Scores range from 700–2,259 (mean = 1,396; standard deviation = 221).

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education.

TABLE 3

Scores on the Pennsylvania System of School Assessment 2007/08 reading test for grade 8 students, by ethnicity

Score	Hispanic (n = 9,040)	White (n = 105,644)	Black (n = 21,869)	Other (n = 4,414)	All non-Hispanic (n = 131,927)
Average score	1,281.18	1,487.47	1,291.76	1,483.61	1,454.90
Standard deviation of score	241.68	230.69	233.05	269.71	243.60
Differences from Hispanic students	na	206.29***	10.58	202.43***	173.72***

*** Significantly different from Hispanic students at $p = 0.001$.

na is not applicable.

Note: The p-values were based on t-tests with adjustment for clustering within schools.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education.

more than 200 (from 211 to 267). The data for answering this second research question were restricted to Hispanic students.

Because the students are clustered (or nested) within these schools, the analysis method selected must be able to handle complex relationships within the data. Multilevel modeling was used because it accounts for the nested structure of the data. For more detail, see appendix E or Raudenbush and Bryk (2002).

TABLE 4

Scores on the Pennsylvania System of School Assessment 2007/08 math test for grade 8 students, by ethnicity

Score	Hispanic (n = 9,040)	White (n = 105,644)	Black (n = 21,869)	Other (n = 4,414)	All non-Hispanic (n = 131,927)
Average score	1,281.13	1,431.28	1,253.87	1,493.46	1,403.96
Standard deviation of score	199.76	210.91	190.65	249.25	219.83
Differences from Hispanic students	na	150.15***	–27.26***	212.33***	122.83***

*** Significantly different from Hispanic students at $p = 0.001$.

na is not applicable.

Note: The p-values were based on t-tests with adjustment for clustering within schools.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education.

Student characteristics included in the regression model were gender, eligibility for free or reduced-price lunch, special education participation, English language learner status, and migrant status. These characteristics were chosen because previous research had identified them as related to performance by racial/ethnic minority students (Freeman 2004; Galindo 2007; McGraw, Lubienski, and Strutchens 2006; Pong 2010; Reardon and Ream 2005; Sanchez et al. 2009; Suárez-Orozco, Gaytán, and Kim 2010), and they were available in the Pennsylvania Department of Education dataset. School characteristics were also selected based on a literature review,[6] as well as availability in the dataset. The model included the percentage of grade 8 students receiving special education services, percentage of grade 8 students who were English language learner students, percentage of students who were Hispanic, percentage of students eligible for free or reduced-price lunch, student–teacher ratio, school size, school with no dropouts, and school location.[7]

Multilevel modeling was used to analyze two dependent variables separately: scaled reading test scores and scaled math test scores. A separate model was estimated for each test (table 5). The intercept in the model is the average achievement of Hispanic students.

When the regression coefficient for a variable was statistically significantly different from zero at the $p = 0.05$ level, the relationship between the variable and the test scores was considered to be statistically significant. In some cases, results are also reported for significance at the $p = 0.001$ level.

Student-level variables

There were statistically significant associations at the $p = 0.001$ level between grade 8 Hispanic students' PSSA test scores and five of the six student-level variables (see table 5):

- Hispanic female students were predicted to score 31 scaled score points higher on the reading test than were Hispanic male students, but Hispanic male students were predicted to score 25 points higher on the math test than were Hispanic female students.
- Hispanic students eligible for free or reduced-price lunch were predicted to score 39 scaled score points lower on the reading test and 25 points lower on the math test than were non-eligible Hispanic students.
- Hispanic students receiving special education services were predicted to score 219 scaled score points lower on the reading test and 190 points lower on the math test than were Hispanic students not receiving special education services.
- Current Hispanic ELL students were predicted to score 238 scaled score

TABLE 5

Multilevel regression results of the association between student- and school-level characteristics and grade 8 Hispanic students' scores on the Pennsylvania System of School Assessment reading and math tests, 2007/08

Statistic and variable	Reading	Math
Standard deviation of test score	241.68	199.76
Intercept	1,286.56*** (5.44)	1,281.14*** (5.08)
Student-level variables		
Male	–31.07*** (4.02)	25.09*** (3.54)
Eligible for free or reduced-price lunch	–38.90*** (5.06)	–24.70*** (4.45)
Special education	–218.60*** (5.40)	–189.72*** (4.76)
Current English language learner	–237.81*** (5.65)	–151.44*** (4.98)
Former English language learner	–51.02*** (6.34)	–24.50*** (5.58)
Migrant	–18.40 (12.93)	1.14 (11.38)
School-level variables		
Percentage of grade 8 students receiving special education services	–4.47 (7.28)	–5.26 (6.60)
Percentage of grade 8 English language learner students	3.83 (6.95)	6.17 (6.37)
Percentage of Hispanic students	–1.63 (3.21)	–0.71 (2.96)
Percentage of students eligible for free or reduced-price lunch	–17.07*** (2.41)	–12.60*** (2.21)
Student–teacher ratio	0.77 (1.46)	0.37 (1.32)
School size	–2.29 (1.22)	–2.83* (1.10)
School with no dropouts	24.74* (12.51)	33.30 (11.19)
Suburban school	–1.57 (14.12)	–2.55 (12.69)
School in town	–10.28 (18.02)	–16.44 (16.12)
Rural school	13.55 (17.12)	–3.09 (15.63)
Between-school variance	102.60***	77.85***
Within-school variance	221.37	186.25
Total variance	323.98	264.10
Percentage of variance explained by the model	24.37	16.96

* Significant at $p = 0.05$; *** significant at $p = 0.001$.

Note: Standard errors are in parentheses.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education and U.S. Department of Education (2008).

points lower on the reading test and 151 points lower on the math test than were Hispanic students who had never been identified as ELL students.

- Hispanic students who were former ELL students were predicted to score 51 scaled score points lower on the reading test and 25 points lower on the math test than were non-ELL students.

School-level variables

One school-level variable was associated with Hispanic students' test scores and was statistically significant at the $p = 0.001$ level (see table 5):

- For every 10 percentage point increase in the proportion of students eligible for free or reduced-price lunch in a school over the mean of all schools, Hispanic students were predicted to score 17 scaled score points lower in reading and 13 points lower in math.

There were also two statistically significant associations at the $p = 0.05$ level between Hispanic students' test scores and school-level variables (see table 5):

- For every 100-student increase in a school's student population over the mean of all schools, Hispanic students

were predicted to score 2.83 scaled score points lower in math.

- Hispanic students attending schools with no dropouts were predicted to score 25 scaled score points higher in reading than were Hispanic students attending schools with dropouts.

No statistically significant association was found between six variables and Hispanic students' test scores in either reading or math. These variables include one student-level variable (whether the Hispanic student is also classified as a migrant child) and five school-level variables (percentage of grade 8 ELL student, percentage of grade 8 students receiving special education services, percentage of Hispanic students, student–teacher ratio, and school locale).

The student- and school-level variables in the model explained about 24 percent of the variation in reading test scores and about 17 percent of the variation in math test scores.

Conclusions

This study adds to the research available to Pennsylvania policymakers and communities as they seek to increase the achievement of the state's Hispanic student population, providing them with more information than simply English language proficiency. This study suggests that decisionmakers remain mindful of the demographic makeup or racial/ethnic proportions of schools, whether the schools have dropouts, the size of the schools, and students' English language ability and socioeconomic status (measured through eligibility for free or reduced-price lunch in this study) when developing scaffolding strategies and instruction proposed to narrow the achievement gap between Hispanic students and other students.

This study used 2007/08 Pennsylvania grade 8 student performance data to compare the academic achievement of the Hispanic student subgroup against the achievement of other student subgroups. Hispanic grade 8 students in Pennsylvania had lower test scores than non-Hispanic students in both reading and math. When the non-Hispanic subgroup was disaggregated into White students, Black students, and other racial/ethnic minority students, Hispanic students were found to score nearly the same on the reading test as Black students and lower than White students and other racial/ethnic minority students. Hispanic students outperformed Black students in math by 27 scaled score points. The authors conclude that the Hispanic performance gaps identified through the 2009 NAEP are supported in the PSSA data and that there were observed differences in academic performance based on a student's self-reported ethnicity.

This study also investigated the relationship between Hispanic student performance and several student- and school-level factors. While 7 of the 14 factors had statistically significant associations, the two with the greatest apparent relationship with student performance were current English language learner status and special education status. A Hispanic student who was also a current ELL student was predicted to score 238 scaled score points lower in reading and 151 points lower in math than a non-ELL Hispanic student. A Hispanic student who was also receiving special education services was predicted to score 219 scaled score points lower in reading and 190 points lower in math than a Hispanic student who was not receiving special education services.

Study limitations

The study methods cannot identify causal relationships between variables. The statistics represent associations between selected independent variables and the dependent variable of Hispanic students' test scores. The analysis provides no information on the cause or reason for the test performance of Hispanic students. The fact that an association between test performance and ELL status was identified should

not be interpreted to mean that ELL status causes lower test performance.

Any findings related to dropouts should be interpreted with caution because of the lack of a common approach to counting dropouts. This study treated the existence of dropouts in a school as a dichotomous variable and did not attempt to explore differences in dropout rates.

Finally, the findings are based on data from the population of grade 8 students in Pennsylvania in 2007/08 and should not be generalized to other states, grades, or school years.

Appendix A
Summary of previous research on Hispanic students' academic achievement

Previous research on Hispanic students has identified several factors associated with their academic achievement, including gender, socioeconomic status, English language proficiency, and migrant status.

- *Gender.* Previous studies found higher math achievement among Hispanic males than among Hispanic females (Freeman 2004; McGraw, Lubienski, and Strutchens 2006; Pong 2010). This difference is especially large for students with high socioeconomic status. However, other research suggests no significant gender difference in reading performance among Hispanic high school students (LoGerfo, Nichols, and Chaplin 2006).
- *Socioeconomic status.* Poverty has long been recognized as a risk factor for education failure (Luthar 1999; Weissbourd 1996). Hispanic students from higher socioeconomic backgrounds(as measured by household income; Sirin 2005; White 1982) tend to have greater math proficiency than their lower socioeconomic counterparts (Pong 2010; Reardon and Galindo 2007). Previous research suggests Hispanic students' low socioeconomic status is one reason their school performance has lagged behind that of White students (Pong, Hao, and Gardner 2005). Studies that focused on Mexican students found that socioeconomic status is a significant predictor of math learning in elementary school (Crosnoe 2006) and of math and reading performance in middle school (Ream 2005).
- *English language proficiency.* Hispanic students with difficulty in the English language have lower performance in reading and math than Hispanic students who are proficient in English (Eamon 2005; Reardon and Galindo 2007; Terwilliger and Magnuson 2005).
- *Special education status.* Sanchez et al. (2009) found that Hispanic students receiving special education services have lower math and English language arts (reading) test scores than do other Hispanic students.
- *Migrant status.* Hispanic students whose parents do seasonal migrant work face many challenges in education, including frequent interruptions in schooling (Suárez-Orozco, Gaytán, and Kim 2010). Several studies without racial/ethnic breakdowns link schools with higher student mobility to lower academic achievement (Hanushek, Kain, and Rivkin 2004; Ream 2005; Rumberger 2002). Although there is no definitive count of migrant workers and children in Pennsylvania, a recent study noted there were 45,000–50,000 migrant farm workers harvesting fruit, mushrooms, and vegetables (Cason and Snyder 2004).

Since the 1960s, researchers have found school social context to be important in children's intellectual development. However, few studies on school effects have focused on Hispanic students. The salient findings on school contexts related to student achievement include:

- *Economic status of the school population.* Students attending schools with a greater percentage of students from high-income family backgrounds tended to show higher academic achievement (Gamoran 1992; Pong 1998; Willms 1992). By contrast, students attending schools with a greater percentage of students eligible for free

or reduced-price lunch tended to score lower on standardized tests (Sirin 2005).

- *Percentage of racial/ethnic minority students.* Several studies found that students had lower academic performance in schools with high concentrations of racial/ethnic minority students (Coleman 1966; Hess and Warden 1988; Pong 1998; Rumberger and Willms 1992). Sanchez et al. (2009) found that Hispanic students attending a school with a high percentage of Hispanic students tended to have lower math and reading test scores.
- *Percentage of students receiving special education services.* Kalambouka et al. (2007) found that students who did not have special education needs were unaffected by attending a school with a high proportion of special education students. Sanchez et al. (2009) found no association between the proportion of special education students in the school and grade 10 Hispanic students' math and reading achievement scores in three of four school years .
- *Percentage of English language learner students.* Hispanic students attending schools with high concentrations of English language learner students (Orfield, Yun, and Project 1999; Schmid 2001; Van Hook and Balistreri 2002) are more likely to have less experienced teachers (Rivkin, Hanushek, and Kain 2005), which may affect their learning. However, schools with higher concentrations of English language learner students also have more Title I services, are more likely to offer support and remedial programs and native language instruction, are more likely to use standardized procedures to identify ELL students, and are more likely to be involved in parent outreach and support activities than schools with lower concentrations (Cohen, Deterding, and Clewell 2005). While Crosnoe (2005) found no significant relationship between Mexican students' math performance and the percentage of students enrolled in English as a second language classes, Sanchez et al. (2009) found positive associations between Hispanic students' math and reading achievement and the percentage of English language learner students in a school in one of three school years.
- *Dropout rates.* Hispanic students have higher dropout rates than other racial/ethnic groups (Fry 2003; Oropesa and Landale 2009). Sanchez et al. (2009) found that Hispanic students in schools with higher dropout rates had lower math and reading performance than their Hispanic peers in schools with lower dropout rates.
- *School size.* The literature on the relationship between school size and student achievement is mixed. While some studies found no significant relationship (Gardner 2001; Milesi and Gamoran 2006) or even a positive relationship (Wyse, Keesler, and Schneider 2008), most reported a negative relationship (Caldas 1993; Fowler and Walberg 1991; Lee and Smith 1997; McMillen 2004). A recent study found that, while Hispanic students from Mexican immigrant families had lower math scores in larger than in smaller schools, other Hispanic students scored higher in larger schools (Crosnoe 2005).
- *Student–teacher ratio.* The student–teacher ratio is an indicator of class size per teacher. Earlier correlational studies of class-size effect on student achievement found that reducing class

size did not increase student achievement (Porwoll 1978; Hallinan and Sorensen 1985). Since the late 1990s, Tennessee's Project STAR, a longitudinal study of math and reading achievement based on a randomized experiment, has dominated the discussion on class size. Project STAR provided evidence that small class size increases student math performance in the primary years (Finn and Achilles 1999). Using the STAR data, researchers found a statistically significant positive effect on racial/ethnic minority students' reading performance in small class sizes (Nye, Hedges, and Konstantopoulos 2004).

- *School locale*. Previous research has not found a significant association between the geographic location of the school (urban, suburban, town, or rural) and student achievement overall (Pong 1998) or achievement of Hispanic students (Crosnoe 2005; Sanchez et al. 2009).

For a more detailed review of the literature, see Sanchez et al. (2009) and Suárez-Orozco, Gaytán, and Kim (2010).

Appendix B. Data removal process

This study used the following two datasets: the Pennsylvania System of School Assessment (PSSA) dataset, obtained from the Pennsylvania Department of Education, and the Common Core of Data of the National Center for Education Statistics (U.S. Department of Education 2008). The PSSA dataset was used for both the descriptive analysis and the multilevel modeling; the Core of Data was used solely for multilevel modeling. The PSSA dataset contained information on both Hispanic and non-Hispanic students, and the Common Core of Data contained information only on Hispanic students. The Common Core of Data also contained school-level variables matched from other sources. This appendix examines how missing data were handled.

Missing data

The PSSA dataset has information on 148,360 grade 8 students for the 2007/08 school year. Some students were removed from the analysis for the following reasons:

- Students attending a school that did not meet school inclusion criteria. That is, they were attending nonpublic schools[8] or were in education settings not defined as schools, such as special programs, centers, or units (including intermediate units, juvenile correction facilities, private or nonpublic schools, and alternative programs without a Pennsylvania Department of Education-issued administrative unit number). The excluded schools were not found in the Common Core of Data either.
- Students who were excluded from testing because of parental request, because they were assessed under the Pennsylvania Alternate System of Assessment, because of extended absence, because they should have but had not yet received an Individualized Education Program, or because they were an English language learner (ELL) student in the first year of enrollment in a U.S. school.
- Students who did not take one or both of the PSSA tests due to medical emergency.

Applying these criteria lowered the number of eligible students to 142,333. Of these, 1,366 were missing either an English language arts (reading) or math score. Excluding students with missing test scores, which constituted less than 1 percent (0.97) of eligible cases, was not expected to affect the descriptive results. Removing these students brought the number of cases for the descriptive analysis down to 140,967 (table B1).

Data were removed in two steps (table B2). Step 1 removed the ineligible cases,

TABLE B1

Data removal information for descriptive analysis, Pennsylvania System of School Assessment 2007/08

Data element	Number
Initial number of grade 8 students	148,360
Exclusion by design	
Attended nonpublic or nonschool program	4,256
Students not assessed	
Parental request	48
Pennsylvania Alternate System of Assessment	1,054
Extended absence	371
Any combination of the above	3
Court/agency placed but did not receive individualized education program	10
English language learner student in first year of enrollment in United States	144
Medical emergency	141
Total eligible cases	142,333
Missing test score data, unknown reason	
Missing English language art test results	1,184
Missing math test results	992
Missing either score	1,366
Final number of cases for analysis	140,967

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education.

TABLE B2

Demographic and background characteristics before and after each step of data removal, Pennsylvania System of School Assessment 2007/08 (percent)

Characteristic	Total grade 8 students	Data removal step 1	Data removal step 2
Gender			
Male	51.7	51.2	51.1
Female	48.3	48.9	48.9
Free or reduced-price lunch			
Eligible	33.8	33.1	32.9
Not eligible	66.2	66.8	67.1
Special education status			
Receiving special education services	17.4	14.9	14.7
Not receiving special education services	82.6	85.1	85.3
English language learner status			
Current English language learner	1.9	1.8	1.8
Former English language learner	1.4	1.4	1.4
Never an English language learner	96.7	96.8	96.8
Migrant status			
Migrant	0.2	0.2	0.2
Nonmigrant	99.8	99.8	99.8
Number of observations	148,360	142,333	140,967

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education.

TABLE B3

Correlations between missing test scores and other student-level variables, 2007/08

Variable	Missing reading score	Missing math score
Missing test scores		
Missing math	0.871	1.000
Missing reading	1.000	0.871
Ethnicity		
Black	0.031	0.014
Hispanic	0.042	0.043
White	–0.060	–0.046
Other	0.018	0.006
Gender		
Male	0.025	0.025
Special education status		
Receiving special education services	0.152	0.166
Free or reduced-price lunch program eligibility		
Eligible	0.066	0.062
English language learner status		
Current English language learner student	0.061	–0.001
Former English language learner student	–0.001	0.001
Never an English language learner student	–0.046	0.000
Migrant status		
Migrant	0.013	–0.001

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education.

including students in nonregular schools, students excluded from testing assessment, and students who did not take the test due to medical emergency. Step 2 removed students who had missing test scores.

The correlations between each missing test score and student-level variables are shown in table B3. The strongest correlation was between the two test scores, suggesting that students who missed one test were highly likely to miss the other. The correlations between special education status and the missing test scores were 0.15 for reading and 0.17 for math. Both correlations were weak. All other correlations were even weaker, at less than 0.07 in absolute value.

Multilevel modeling

The descriptive analysis used data for both Hispanic and non-Hispanic students, but the multilevel modeling analyzed Hispanic students only. The dataset used for multilevel

modeling had 9,040 students (a subset of the full dataset of 140,967). These data came from both the PSSA dataset and the Common Core of Data. The PSSA data provided student-level variables. School-level variables were either constructed from aggregating information from the PSSA or extracted from the Common Core of Data.

Gender was the only student-level variable with missing data. A dummy variable indicating missing gender was included in the multilevel regression to account for "missing," so that no student-level data were removed. Two school-level variables were constructed from the PSSA: the percentage of grade 8 students receiving special education services, and the percentage of grade 8 English language learner students. There were no missing data.

However, there were many missing values for the school-level variables from the Common Core of Data. Multiple imputation was used to impute values for these variables. The imputation procedure created five school-level datasets—each merged with the student-level dataset—creating five datasets that had both student- and school-level variables. Appendix C provides more information on the imputation procedure.

Appendix C
Multiple imputation

This appendix describes how multiple imputation (Rubin 1987; Schafer 1997) was applied to address the missing school-level data in the Common Core of Data. Whereas there was not a substantial amount of data missing from the student-level Pennsylvania System of School Assessment (PSSA) dataset, values were missing in 33 percent of the 604 schools in the data from the Common Core of Data. Missing data could lead to biased estimates of the association between school variables and student test scores. This problem can be remedied by imputing the missing data.

Multiple imputation is a simulation approach to analyzing incomplete data. It assumes the mechanism of missingness to be "missing at random." This means that there is a systematic pattern of missingness (for example, missing on income correlated with low level of education) and that missing data can be correlated with other variables in the dataset. Missing at random is the most common imputation assumption for multivariate analysis (Allison 2002; Graham 2009).

Multiple imputation replaces each missing observation with a number of simulated values, creating multiple datasets. This method creates multiple imputations by using simulations from a Bayesian prediction distribution for normal data and includes two steps: drawing values for the variables with missing values for a particular observation from a conditional distribution given the variables with observed values; and simulating the posterior population means, variances, and covariances from the complete sample estimates. The first step is then repeated using these new estimates. These two steps are repeated until the iterates converge to their stationary distribution—to reliably create a multiply imputed dataset (Schafer 1997).

The multiple imputation method is superior to single imputation methods, such as mean substitution or regression imputation (Allison 2002; Graham 2009). Single imputation methods tend to produce biased estimates, and the standard errors are biased downward. The multiple imputation method repeats the imputation process several times so that the point estimates are unbiased and the standard errors across imputations can be used to adjust the standard errors upward (Allison 2002).

Researchers have suggested that using auxiliary variables, including interaction terms, may reduce bias and increase efficiency (Collins et al. 2001). In the imputation model, covariates that were available but not in the multilevel models were used to help predict missing values. There were 11 auxiliary variables. Five of the 11 were constructed from averaging student data from the PSSA.

- Percentage of grade 8 students who were eligible for free or reduced-price lunch.
- Percentage of grade 8 students who were Hispanic students.
- Percentage of grade 8 students who were Black students.
- Percentage of grade 8 students who were White students.
- Percentage of grade 8 students who were migrant students.

The other six auxiliary variables were extracted from the Common Core of Data:

- Lowest grade in the school.
- Highest grade in the school.
- Title I school (all students designated as eligible for participation in programs authorized by Title I of Public Law 103-382).
- Magnet school.
- Charter school.
- School dropout rate in 2006/07.

Additionally, interactions of available student- and school-level covariates were used in the imputation procedure. There were 20 interaction terms in the imputation model, each constructed by multiplying two variables. One variable was at the school-level (from the Common Core of Data) and the other represented the school-average of student-level data (from the PSSA). For example, the percentage of grade

8 ELL students and school size were multiplied to create an interaction variable. Four variables from averaging the PSSA data were used: percentage of grade 8 ELL students, percentage of grade 8 students receiving special education services, percentage of grade 8 students from low-income households, and percentage of grade 8 Hispanic students. All but one of these student-level variables were used in the multilevel models to predict test scores for Hispanic students. Migrant status was not used to construct interaction variables because the percentage of migrants in the student population was small (about 3 percent). Five of the eight school-level variables (from the Common Core of Data) were used in the multilevel models: number of students receiving free school lunch, school size, total number of Hispanic students, student–teacher ratio, and school dropout rate for 2007/08. The other three variables were not used because they did not contain missing data and were entered in the imputation model as main effects only. With four variables from the PSSA and five from the Common Core of Data, there were a total of 20 interaction variables.

Before multiple imputation, the amount of missing data for the original variables (excluding interaction terms) was examined (table C1). Ten school-level variables had no missing values: school locale, magnet school, charter school, and seven

TABLE C1

Missing data for each variable in the school dataset, 2007/08

School variable	Number of nonmissing	Number of missing	Percent missing
Main variables			
Percentage of grade 8 English language learner students	604	0	0.00
Percentage of grade 8 students receiving special education services	604	0	0.00
Number of Hispanic students	586	18	2.98
Number of students eligible for free or reduced-price lunch	510	94	15.56
Student–teacher ratio	591	13	2.15
School size	596	8	1.32
Dropout rate	594	10	1.66
School locale	604	0	0.00
Auxiliary variables			
Percentage of grade 8 students eligible for free or reduced-price lunch	604	0	0.00
Percentage of grade 8 Hispanic students	604	0	0.00
Percentage of grade 8 Black students	604	0	0.00
Percentage of grade 8 White students	604	0	0.00
Percentage of grade 8 migrant students	604	0	0.00
Percentage of grade 8 English language learner students	604	0	0.00
Lowest grade in school	599	5	0.83
Highest grade in school	599	5	0.83
Title I school	488	116	19.21
Magnet school	604	0	0.00
Charter school	604	0	0.00
Dropout rate 2006/07	603	1	0.17

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education and U.S. Department of Education (2008).

variables representing the percentages of grade 8 student characteristics (English language learner students, students receiving special education services, students eligible for free or reduced-price lunch, and Black, Hispanic, White, and migrant students). The variable Title I school had the largest number of missing values—19.2 percent of the 604 schools did not report Title I status.

Overall, 404 schools had no missing values, 95 schools had 1–2 missing values, and another 95 schools had 5–10 missing values. A small number of schools (10 schools) had more than 10 missing values; eight of those schools had predominately missing values (28 or 30). These 8 schools were excluded for the sensitivity analysis (appendix D).

The imputation model was estimated using the command "ICE" (imputation by chain equations) in STATA (Royston 2004). Depending on the variables to be imputed, three types of models were used: ordinary least squares regression for continuous variables, such as the percentage of students eligible for free or reduced-price lunch or the dropout rate;[9] logistic regression for dichotomous variables, such as charter or magnet school; and multinomial logistic regression for categorical variables, such as the school's location in urban, suburban, town, or rural areas. All imputed variables were originals from the PSSA or Common Core of Data.

The imputation model produced five imputed datasets. Each dataset was analyzed in an identical fashion and was then combined to yield a single set of results based on Rubin's rules (Rubin 1987). The point estimate for a particular parameter was the average of the five estimates from the five imputed datasets. The variance estimate was calculated from the within-imputation and between-imputation variances, both weighted by the number of imputations (Schafer 1997).

One way to examine whether the multiple imputations were done properly is to inspect the mean and standard deviation of each original and imputed variable to see whether the statistics are similar. The school-level variables that were used in the multilevel model analysis and that had missing values were examined (table C2). The average values of each school variable before and after imputation were very similar. The standard deviations were also similar, except for the percentage of students eligible for free or reduced-price lunch, which had a larger standard deviation after imputation. This result is not surprising given that the amount of missingness was highest for the percentage of students eligible for free or reduced-price lunch (about 16 percent). Overall, the distributions of the school variables with missing data were similar before and after multiple imputation.

TABLE C2

Comparison between school means, with and without imputation, school-level data 2007/08

	With imputation		Without imputation		
School characteristics (n = 604)	Mean	Standard deviation	Mean	Standard deviation	Percent missing
Percentage of Hispanic students	8.97	17.75	9.19	16.63	2.98
Percentage of students eligible for free or reduced-price lunch	42.34	33.18	40.74	28.10	15.56
Student–teacher ratio	14.05	3.76	14.05	3.73	2.15
School size (number of students)	683.91	449.53	684.07	447.75	1.32
Percentage of school with no dropout	83.31	0.38	84.18	0.37	1.66

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education and U.S. Department of Education (2008).

Appendix D
Sensitivity analyses

Two sensitivity analyses were conducted. The first was restricted to the sample of students with no missing data. Listwise deletion was used to construct this sample. A total of 1,010 students and 105 schools were dropped, resulting in a sample of 8,030 students in 499 schools. Table D1 shows the multilevel regression results.

The coefficients and significance levels of the student-level variables were similar to those in the main model (table 5 in the main report). However, some estimates differed at the school level. The percentage of grade 8 students receiving special education services had the opposite sign in the models predicting both test scores. The rural school and school size variables had the opposite sign in the models predicting math scores. Of these, only school size was statistically significant ($p = 0.05$) in the main model.

Although the percentage of students eligible for free or reduced-price lunch was statistically significant at the $p = 0.001$ level in both tables 5 and D1, school locale (suburban school for both reading and math, town school for reading only, and rural school for math only) was significantly associated with test scores only in table D1. Also, school size (math) and school without dropouts (reading) were significant in only table 5.

The results from the first sensitivity analysis indicate that the findings are sensitive to excluding cases based on missing data.

The second sensitivity analysis was restricted to a sample of 8,938 students within 596 schools. This analysis excluded 102 students in the 8 schools that had mostly missing values. The multilevel regression results were very similar to the results in table 5, suggesting that dropping the 8 schools made little difference to the estimation of the association between test scores and the student- and school-level characteristics (table D2).

TABLE D1

Sensitivity analysis based on the sample without missing values

Statistic and variable	Reading	Math
Standard deviation of test score	241.679	199.757
Intercept	1289.380***	1285.563***
Student-level variables		
Male	–29.959***	25.234***
Receiving special education services	–216.566***	–189.171***
Eligibility for free or reduced-price lunch	–39.738***	–22.927***
Current English language learner student	–240.126***	–153.859***
Former English language learner student	–48.487***	–23.844***
Migrant student	–16.610	1.972
School-level variables		
Percentage of grade 8 students receiving special education services	0.738	1.051
Percentage of grade 8 English language learner students	0.397	2.711
Percentage of Hispanic students	–1.143	–0.406
Percentage of students eligible for free or reduced-price lunch	–21.962***	–14.955***
Student–teacher ratio	0.687	0.194
School size	–0.834	0.287
School with no dropouts	15.179	25.576*
Suburban school	–39.703*	–23.356
Town school	–45.367*	–35.517*
Rural school	–27.284	–33.902*
Between-school variance	100.852***	73.955***
Within-school variance	221.780	187.341
Total variance	322.632	261.296
Percentage of variances explained by the model	24.686	16.815

* Significant at $p = 0.05$; *** significant at $p = 0.001$.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education. and U.S. Department of Education (2008).

TABLE D2

Sensitivity analysis based on the sample without the eight schools that had mostly missing values

Statistic and variable	Reading	Math
Standard deviation of test score	241.679	199.757
Intercept	1398.783***	1323.521***
Student-level variables		
Male	–30.750***	25.307***
Receiving special education services	–218.807***	-190.030***
Eligibility for free or reduced-price lunch	–38.781***	–24.180***
Current English language learner student	–237.880***	–151.263***
Former English language learner student	–50.469***	–24.673***
Migrant student	–18.920	0.849
School-level variables		
Percentage of grade 8 students receiving special education services	–2.790	–4.341
Percentage of grade 8 English language learner students	3.508	6.221
Percentage of Hispanic students	–1.552	–0.765
Percentage of students eligible for free or reduced-price lunch	–18.507***	–13.587***
Student–teacher ratio	1.039	0.474
School size	–2.622*	–2.960***
School with no dropouts	20.885	30.758***
Suburban school	–10.742	–8.227
Town school	–18.004	–21.931
Rural school	5.756	–8.938
Between-school variance	88.178***	68.935***
Within-school variance	221.816	186.432
Total variance	309.994	255.367
Percentage of variances explained by the model	22.507	14.950

* Significant at $p = 0.05$; *** significant at $p = 0.001$.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education. and U.S. Department of Education (2008).

Appendix E
Study methods

This study used descriptive and multilevel modeling to answer two research questions:

- How does the performance of Pennsylvania grade 8 Hispanic students on the 2007/08 Pennsylvania System of School Assessment English language arts and math tests compare with that of grade 8 non-Hispanic White, Black, and other non-Hispanic students?
- Among Pennsylvania grade 8 Hispanic students, which student- and school-level characteristics are associated with performance on the 2007/08 Pennsylvania System of School Assessment English language arts and math tests?

Datasets for the analyses

This report uses student- and school-level data from three sources (table E1).

Student-level data came from the PSSA dataset. In addition to student performance on English language arts (reading) and math, the PSSA dataset provided information on student demographic characteristics (ethnicity, gender, special education status, eligibility for free or reduced-price lunch, English language learner status, and migrant status). Ethnicity was self-reported, with students asked to select the ethnicity with which they identify most closely. Students choosing the category "two or more races" were included in the "other ethnicities" subgroup.

School-level data for 2007/08 for all public schools in Pennsylvania were collected for grade 8 students included in the PSSA database. Student-level data were aggregated or averaged within schools to create the school-level variables (see below).

Demographic data for all Pennsylvania public schools were taken from the National Center for Education Statistics 2007/08 Common Core of Data (U.S. Department of Education 2008). The variables, which were comparable across schools, included the percentage of Hispanic students, percentage of students receiving free or reduced-price lunch, percentage of students receiving special education services, percentage of English language learner students, student–teacher ratio, school size, and school locale (urban, suburban, town, rural).

TABLE E1
Student- and school-level variables included in the multilevel regression model

Pennsylvania System of School Assessment	Common Core of Data	Pennsylvania Department of Education website
• Gender • Special education status • Eligibility for free or reduced-price lunch[a] • Current English language learner student • Former English language learner student • Migrant student • Percentage of students receiving special education services • Percentage of English language learner students	• Percentage of Hispanic students • Percentage of students receiving free or reduced-price lunch[a] • Student–teacher ratio • School size • School locale (urban, suburban, town, rural)	• Dropout

a. Eligibility for free or reduced-price lunch is used as a proxy measure of low-income status.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education and U.S. Department of Education (2008).

Dropout rates for each school in 2007/08 were collected from the Pennsylvania Department of Education website.

The Common Core of Data contains unique state school identification numbers, and the Pennsylvania Department of Education data contains school names, which served as linking variables. Both state school identification numbers and school names were available in the PSSA data, enabling dataset merging.

Outcome variables used for the analyses

Scaled scores for the reading and math tests were used in both the descriptive and multilevel regression analyses. The scaled score range for the reading test was 700–2,646, with a mean of 1,443.76 and standard deviation of 247.17. Half the items on the test were related to comprehension and reading skills and the remaining items were based on interpretation and analysis of fictional and nonfictional text.

The scaled score range for the math test was 700–2,259, with a mean of 1,396.08 and standard deviation of 220.66. Of the 66 items on this test, 14 were related to numbers and operations, 10 to measurement, 12 to geometry, 20 to algebraic concepts, and 10 to data analysis and probability.

More information on the 2007/08 PSSA instruments and analyses can be found in the *Technical Manual for the Pennsylvania System of School Assessment* (Data Recognition Corporation 2009).

Independent variables used for the analyses

All six student background variables came from the 2007/08 PSSA.

- *Hispanic student.* Whether a student had self-identified as Hispanic. The comparison group is non-Hispanic as a single group or White, Black, or "other" students (includes several subgroups; for example, Asian and Native American).
- *Gender.* Whether a student is reported as male. The comparison group is female. A small number of students did not report their gender. A dummy variable was constructed to represent missing gender.
- *Special education services.* Whether a student had an Individualized Education Program (not including gifted programs).
- *Eligibility for free or reduced-price lunch.* Children from families with incomes at or below 130 percent of the poverty level are eligible for free meals. Children from families receiving Temporary Assistance for Needy Families or food stamp benefits automatically qualify for free meals. Children from families whose income is 130–185 percent of the poverty level are eligible for reduced-price meals (Pennsylvania Department of Education n.d. b).
- *English proficiency.* Whether a student had been assessed and identified as an English language learner student in 2007/08 or as a former English language learner who exited an English as a second language/bilingual program before 2007/08. The comparison group is students who had never been identified as an English language learner student.
- *Migrant status.* Refers to "any child domiciled temporarily in any school district for the purpose of seasonal or temporary employment, but not acquiring residence therein, and any child accompanying his parent or guardian who is so domiciled" (Pennsylvania Department of Education 2008, p. 6). School personnel make this designation.

School-level variables used in the multilevel modeling regressions include the following:

- *Percentage of grade 8 students receiving special education services.* The number of grade 8 students receiving special

education services in a school divided by the total number of grade 8 students and multiplied by 100.

- *Percentage of grade 8 English language learner students.* The number of grade 8 students identified by the school as current or former English language learner students divided by the total number of grade 8 students and multiplied by 100.
- *Percentage of Hispanic students.* The number of Hispanic students divided by the total number of students in the school and multiplied by 100.
- *Percentage of students eligible for free or reduced-price lunch.* The number of students eligible for free or reduced-price lunch divided by the total number of students in the school and multiplied by 100.
- *Student–teacher ratio.* The total number of students in the school divided by the total number of full-time equivalent classroom teachers in the school.
- *School size.* The total number of students in the school.
- *School without dropouts in 2007/08.* Dropout rates are often considered a measure of school quality. Research has shown that dropout rates are negatively associated with student achievement (see appendix A). Thus, dropout rates are a meaningful concept in the study of student achievement. Dropouts, though more common in high school, were also found in middle school. Even a small number of dropouts within a school can indicate a risk factor for students. All schools in Pennsylvania reported a dropout rate. The majority (84 percent) of the schools in the dataset had no dropouts (dropout rate = 0). Using a linear specification of the dropout rate did not reveal any significant relationship between dropout rate and test scores. The dropout rates were recoded as a dichotomous variable (school without dropouts) to differentiate schools that had some dropouts from schools that had none.
- *School locale.* The National Center for Education Statistics defines the urban-centric locale of schools in 12 categories. These categories were collapsed into four: urban (large, midsize, and small cities), suburban (large, midsize, and small suburbs), town (fringe, distant, and remote towns), and rural (fringe, distant, and remote rural areas) locales. Urban schools are the reference group in the multivariate analysis.

Descriptive analyses

Summary statistics were used to describe the PSSA performance of Hispanic and non-Hispanic students, and the descriptive statistics provided a demographic profile of Hispanic students and non-Hispanic students, either as a whole or separately as non-Hispanic White, non-Hispanic Black, or other non-Hispanic students.

The descriptive statistics for all categorical variables are shown as percentages. These include all student-level variables except test scores. For continuous variables, which include all school-level variables, descriptive statistics are shown as means and standard deviations.

To answer the first research question, the differences in the mean scores for Hispanic and non-Hispanic students were examined. Significance tests were performed based on *t*-tests with adjustment for clustering within schools.

Multilevel modeling procedures

To answer the second research question, multilevel regression modeling was used to examine how student and school characteristics can account for the performance of Hispanic students. The variables used are defined in table E2. Because students are clustered within schools and share many of the same school

experiences of interest to researchers, their characteristics are not independent. Cluster sampling violates the ordinary least squares assumption of independent errors and would bias the ordinary least squares estimates. An appropriate method for this type of data structure is multilevel modeling, which corrects for the bias by incorporating a unique random effect for each school. Furthermore, the multilevel model allows for simultaneous estimation of student- and school-level effects by positing a set of relationships at both the individual student and aggregate levels between schools (Raudenbush and Bryk 2002). A two-level multilevel model was applied. The first level units were students, who were nested within the second level units, schools. Formally, a student-level equation was specified as:

$$Y_{ij} = \beta_{oj} + \beta_{1j}(gender)_j + \beta_{2j}(special\_ed)_j + \beta_{3j}(low\_inc)_j + \beta_{4j}(ELL)_j + \beta_{5j}(ELL\_former)_j + \beta_{6j}(migrant)_j + \varepsilon_{ij}$$

where Y_{ij} were math or reading test scores, and ε_{ij} were student-specific random errors. All independent variables in the student-level equation were categorical variables, entered uncentered in the model. The second level units were schools, and the school-level equations were specified as:

$$\beta_{oj} = \gamma_{00} + \gamma_{01}(\%special\_ed)_j + \gamma_{02}(\%ELL)_j + \gamma_{03}(dropout)_j + \gamma_{04}(\%Hispanics)_j + \gamma_{05}(\%low\_inc)_j + \gamma_{06}(stu\_teach\_ratio)_j + \gamma_{07}(sch\_size)_j + \gamma_{08}(locale\_urban)_j + \gamma_{09}(locale\_town)_j + \gamma_{10}(locale\_rural)_j + u_{0j}$$

$$\beta_{1\to6\ j} = \gamma_{1\to6\ 0}$$

The aim was to examine what student and school characteristics were associated with Hispanic student achievement. The school mean achievement (the intercept $\beta_{oj,}$) was specified as random and all other first-level slopes as fixed. All variables were entered grand-mean centered so that the intercept, γ_{00}, can be interpreted as the overall average test score in the data.

A null multilevel model was first estimated without any covariates to examine the variances within and between schools. Model 1 then added all student-level variables. Model 2 added school-level variables to measure the extent to which student and school characteristics are associated with the test scores of Hispanic students. The results of this full model are presented in table 5 in the main report. Two-tailed *t*-tests were used to show whether the association between the test score and a variable was significantly different from zero at the standard level of significance of 0.05. The percentage of variance explained by the model was obtained by comparing the total variances of the null model and the variances of the full model. Tables E3 and E4 provide more detailed results. The null model shows that school-level variables explain about 32 percent of reading test scores (102.604/323.976 × 100) and 29 percent of math test scores (77.849/264.097 × 100). The student-level variables explain about 19 percent of the reading test scores and 14 percent of the math test scores. Adding the school-level variables improved the explained variances by only 4 percent for both test scores. Also, adding the school-level variables in the model did not change the level of significance of the student-level variables.

TABLE E2

Independent variables used in multilevel modeling

Variable	Definition
Student-level variables	
Hispanic student	1 = Hispanic student; 0 = non-Hispanic student
Non-Hispanic White student	1 = non-Hispanic White student; 0 = not non-Hispanic White student
Non-Hispanic Black student	1 = non-Hispanic Black student; 0 = not non-Hispanic Black student
Other non-Hispanic student[a]	1 = other non-Hispanic student; 0 = not other non-Hispanic student
Gender	1 = male student; 0 = female student
Special education status[b]	1 = receiving individualized education program ; 0 = not receiving individualized education program
Eligible for free or reduced-price lunch	1 = Eligible student; 0 = not eligible student
Not English language learner student	1 = Not English language learner student; 0 = English language learner student (reference)
Current English language learner student	1 = current English language learner student who has been assessed and identified as English language learner; 0 = not current English language learner student
Former English language learner student	1 = former English language learner student who has exited a English as a second language/bilingual program; 0 = not former English language learner student
Migrant status	1 = migrant student; 0 = not migrant student
School-level variables	
School size	Continuous variable; centered around the average school size across all schools in the data (unit of change = 100 students)
Percentage of grade 8 English language learner students	Continuous variable; centered around the average percentage of grade 8 English language learner students across all schools in the data (unit of change = 10 percentage points)
Percentage of grade 8 students receiving special education services	Continuous variable; centered around the average percentage of grade 8 students receiving special education services across all schools in the data (unit of change = 10 percentage points)
Percentage of Hispanic students	Continuous variable; centered around the average percentage of Hispanic students across all school in the data (unit of change = 10 percentage points)
Percentage of students eligible for free or reduced-price lunch	Continuous variable; centered around the average percentage of free or reduced-price lunch eligible students across all schools in the data (unit of change = 10 percentage points)
Student–teacher ratio	Continuous variable; centered around the average student–teacher ratio across all schools in the data (unit of change = 1 student per teacher)
School without dropouts	1= school dropout rate is zero; 0 = school dropout rate is not zero
Urban school	1 = urban (large, midsize, and small cities); 0 = not urban (reference)
Suburban school	1 = suburban (large, midsize, and small suburbs); 0 = not suburban
Town school	1 = town (fringe, distant, and remote towns); 0 = not town
Rural school	1 = rural (fringe, distant, and remote rural areas); 0 = not rural

a. Students self-report as one of six ethnic groups: American Indian/Alaskan Native, Asian/Pacific Islander, non-Hispanic Black/African American, Latino/Hispanic, non-Hispanic White, and multiracial. In this report, "other non-Hispanic" includes American Indian/Alaskan Native, Asian/Pacific Islander, and multiracial groups.

b. Excludes gifted programs.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education.

TABLE E3

Multilevel regression results of the association between student- and school-level characteristics and grade 8 Hispanic students' scores on the Pennsylvania System of School Assessment reading tests, 2007/08 (*n* = 9,040)

	Null model			Model 1			Model 2		
Statistic and variable	Coefficient	Standard error	Significance level	Coefficient	Standard error	Significance level	Coefficient	Standard error	Significance level
Intercept	1,332.078	6.035	0.000	1,317.290	4.806	0.000	1,286.560	5.458	0.000
Student-level variables									
Gender				–30.656	4.032	0.000	–31.071	4.020	0.000
Missing gender				–205.737	202.485	0.310	–259.342	197.163	0.189
Special education				–217.983	5.415	0.000	–218.599	5.407	0.000
Eligibility for free or reduced-price lunch				–47.564	5.058	0.000	–38.900	5.068	0.000
Current English language learner student				–239.289	5.658	0.000	–237.857	5.658	0.000
Former English language learner student				–52.142	6.359	0.000	–51.020	6.344	0.000
Migrant				–15.308	12.965	0.238	–18.396	12.934	0.155
School-level variables									
Percentage of grade 8 special education students								–4.467	7.299
Percentage of grade 8 English language learner students								3.828	6.953
Percentage of Hispanic students							–1.628	3.200	0.611
Percentage of students eligible for free or reduced-price lunch							–17.065	2.428	0.000
Student–teacher ratio							0.774	1.455	0.595
School size							24.743	12.520	0.049
School with no dropouts							–2.294	1.247	0.066
Suburban school							–1.572	14.224	0.912
School in town							–10.279	18.021	0.569
Rural school							13.550	17.116	0.429
Variance components									
Between-school variance	102.604***			77.522***			58.127***		
Within-school variance	221.372			186.961			186.912		
Total variance	323.976			264.483			245.039		
Total variance explained (percent)	na			18.363			24.365		

na is not applicable.

*** Significant at $p = 0.01$.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education and U.S. Department of Education (2008).

TABLE E4

Multilevel regression results of the association between student- and school-level characteristics and grade 8 Hispanic students' scores on the Pennsylvania System of School Assessment math tests, 2007/08 (*n* = 9,040)

	Null model			Model 1			Model 2		
Statistic and variable	Coefficient	Standard error	Significance level	Coefficient	Standard error	Significance level	Coefficient	Standard error	Significance level
Intercept	1306.810	4.748	0.000	1298.950	4.099	0.000	1281.140	5.084	0.000
Student-level variables									
Gender				25.229	3.546	0.000	25.088	3.539	0.000
Missing gender				–217.024	177.122	0.221	–264.080	174.300	0.130
Special education				–189.194	4.762	0.000	–189.717	4.762	0.000
Eligibility for free or reduced-price lunch				–30.511	4.417	0.000	–24.700	4.458	0.000
Current English language learner student				–151.954	4.973	0.000	–151.443	4.983	0.000
Former English language learner student				–25.006	5.590	0.000	–24.505	5.587	0.000
Migrant				2.480	11.401	0.828	1.135	11.386	0.944
School-level variables									
Percentage of grade 8 special education students								–5.255	6.586
Percentage of grade 8 English language learner students								6.172	6.377
Percentage of Hispanic students							–0.705	2.935	0.810
Percentage of students eligible for free or reduced-price lunch							–12.602	2.212	0.000
Student–teacher ratio							0.372	1.305	0.776
School size							33.296	11.192	0.003
School with no dropouts							–2.825	1.109	0.011
Suburban school							–2.552	12.806	0.842
School in town							–16.437	16.119	0.308
Rural school							–3.088	15.633	0.843
Variance components									
Between-school variance	77.849***			65.355***			54.831***		
Within-school variance	186.248			164.542			164.462		
Total variance	264.097			229.897			219.293		
Total variance explained (percent)	na			12.950			16.965		

na is not applicable.

*** Significant at $p = 0.01$.

Source: Authors' analysis of data from the 2007/08 Pennsylvania System of School Assessment provided by the Pennsylvania Department of Education and U.S. Department of Education (2008).

Notes

1. This study uses eligibility for free or reduced-price lunch is used as a proxy for socioeconomic status.
2. Eighty-four percent of the schools in this study reported no dropouts, and an initial analysis found no statistically significant relationship between a school's reported dropout rate and Hispanic student performance. The relationship was revealed when the variable was recoded as a dichotomous variable indicating only whether or not dropouts were reported for a particular school. See appendix E for a discussion of the variables used in this study.
3. NAEP scaled scores in math and reading typically range from 0 to 500.
4. In addition, every Pennsylvania student in grade 5, 8, or 11 is assessed in writing; every student in grade 4, 8, or 11 is assessed in science
5. Ethnic groups other than Hispanic, Black, and White had small numbers in the dataset and were aggregated into "other ethnicities" to reduce the risk of disclosure. Student ethnicity is determined in Pennsylvania through student self-reports. A student indicating more than one ethnicity was put into the "other ethnicities" subgroup.
6. Clewell 2005; Cohen, Deterding, and Fry 2003; Coleman 1966; Crosnoe 2005; Finn and Achilles 1999; Gamoran 1992; Hallinan and Sorensen 1985; Hess and Warden 1988; Oropesa and Landale 2009; Pong 1998; Porwoll 1978; Rumberger and Sirin 2005; Suárez-Orozco, Gaytán, and Kim 2010; Rivkin, Hanushek, and Kain 2005; Milesi and Gamoran 2006; Nye, Hedges, and Konstantopoulos 2004; Wyse, Keesler, and Schneider 2008; Willms 1992.
7. Eighty-four percent of the schools included in this study reported no dropouts, and an initial analysis found no statistically significant relationship between a school's reported dropout rate and Hispanic student performance. Since previous research indicated that school-level dropout is an important factor, we re-coded the dropout rate as "school without dropout", a dichotomous variable indicating only whether or not a school reported any dropouts. Please see appendix E for a discussion of the variables used in the study.
8. Charter schools are considered public schools in Pennsylvania.
9. The dropout rate continuous variable was converted to the "school without dropout" dichotomous variable for the purpose of this study, as described in appendix E.

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